

UIL OTS research group 4: *Language and speech: processing and disorders*

Self-reflection (version 18 September 2018)

1. Introduction

1.1 Introduction

The LSPD research group unites four chairs: *Comparative Psycholinguistics* (Avrutin), *Clinical Language, Speech, and Hearing Sciences* (Gerrits), *Psycholinguistics* (Wijnen), and *Quantitative Methods of Empirical Research in the Humanities* (Quené).

Other members are:

- (UDs) Iris Mulders (also lab coordinator), Hugo Schnack (also UMCU), Shalom Zuckerman
- (Postdocs) Tessel Boerma, Ao Chen (also Beijing Language and Culture University)
- (PhD cand's) Gerda Bruinsma, Desiree Capel, Anniek van Doornik, Marjolein van Egmond, Emma Everaert, Maartje de Klerk (also babylab manager), Silvia Radulescu, Iris Selten, Ingrid Singer, Yuan Xie
- (Affiliates) Lizet van Ewijk (HU), Brigitta Keij (Auris), Hayo Terband, Rob Zwitserlood (HU)
- (Alumni) Ileana Grama (lecturer, University of Amsterdam), Carolien van den Hazelkamp (lecturer, UU)

The group has partnerships with the *HU University of Applied Sciences* research group 'Speech and Language Therapy'¹, and the *Koninklijke Aurisgroep*², a center for care and education for children with language disorders. In the framework of the UU strategic research theme *Dynamics of Youth*, we are part of the the *Child Expertise Center*³ and work with researchers in the Faculties of *Social and Behavioral Sciences* (special education, developmental psychology), *Sciences* (cell biology), and the *University Medical Centre* (translational neuroscience, Brain Center Rudolf Magnus, Wilhelmina Children's Hospital). In two projects on speech/language disorders, we also collaborate with the UMCU departments of rehabilitation medicine and otolaryngology. We have an ongoing collaboration with the ACLC (University of Amsterdam)⁴ and are active members of the *Baby Brain and Cognition* research network⁵. Current international partners are the Laboratory for Speech Perception at Université Paris Descartes (France), the Beijing Language and Culture University (China), the University of Maryland at College Park (USA; Linguistics, Hearing and speech), Charles Sturt University (Australia), and the University of Toronto, Canada (psychiatry/ Sick Kids)

¹ <https://www.research.hu.nl/Kenniscentra/Gezond-en-Duurzaam-Leven/Logopedie-Participatie-door-Communicatie>

² <https://www.auris.nl/>

³ <https://www.uu.nl/en/research/dynamics-of-youth/childexpertisecenter>

⁴ <http://progracy.com/>

⁵ <https://www.nwo.nl/onderzoek-en-resultaten/cases/baby-brein--cognitie-netwerk.html>

1.2 Profile

Producing and understanding language, as well as the ontogenesis of these abilities, are determined by the structure and function of the human brain, the senses and the motor apparatus. One of the missions of the field of linguistics is to describe and explain how the brain/mind gives rise to language. The LSPD group aims to contribute to this mission by studying language acquisition and language processing in typical and atypical populations. We specifically take a (neuro)cognitive perspective. Our research thus aims at uncovering the mechanisms that enable humans to translate physical stimuli into meaning; how this translation takes place in real time at all levels: phonological, morphological, syntactic and discourse; at investigating what happens with these mechanisms in situations of typical and abnormal development and disruption. We assume that studying disorders contributes to our understanding of the intact system. However, our work on disordered language not only serves a scientific objective. It is also meant to contribute to generating knowledge about language pathologies that may benefit clinical practices concerning adults and children with speech-language disorders.

The research in our group is interdisciplinary; we connect concepts and methods from linguistics with concepts and methods from cognitive psychology, speech science, neuroscience, and the applied field of speech-language pathology. Methodologically, we exercise a cognitive science approach; pairing explicit theorizing with innovative and methodologically advanced behavioral and neurocognitive empirical work, employing a variety of experimental techniques, ranging from the low-tech and offline (e.g. truth-value judgment, head-turn preference) to high-tech (eye tracking, EEG, fNIRS). Our work is definitely not restricted to Dutch; during recent years projects have also involved a range of other languages. Given its interdisciplinary character, our work is well-positioned within the Utrecht University strategic research theme *Dynamics of Youth*⁶, and is expected to help us getting access to funding supplied through the program *Dutch National Research Agenda*⁷, which will be of major importance in the coming years. We have also profited from support from UU research focus areas *Neuroscience and Cognition* and *Education for Learning Societies*.

We engage with both academic and professional audiences. To fulfill our scientific mission we need to interact with our academic peers by presenting the results of our work through publications and contributions to conferences and research collaborations. Much of our work connects with, and is informed by the field of speech-language pathology and therapy. This entails not only that we share our research results with professionals in this domain, but also that we frequently collaborate with them in a variety of ways.

⁶ <https://www.uu.nl/en/research/dynamics-of-youth>

⁷ <https://wetenschapsagenda.nl/?lang=en>

1.3 Ambition

The primary *scientific* ambition of our group is to make significant and innovative contributions to our knowledge about the (neuro)cognitive substrate of language processing and language acquisition. The approach we have developed consists of three key elements. First, we concentrate our efforts on contributions of (putatively) domain-general cognitive mechanisms and processes to language processing and language acquisition, notably implicit statistical learning from sensory input, the mind/brain's (limited) information processing capacity (mediated by attention, or short-term/working memory), and self-monitoring. Secondly, we try to juxtapose language processes under normal conditions and atypical, notably impaired language processes, so as to determine if extremes of ability can be accounted for by variations in the functioning of hypothesized underlying (domain-general) mechanisms. For example, in view of evidence indicating that implicit statistical learning plays an important role in first language acquisition, we explore if delayed or disordered language acquisition is associated with impaired statistical learning, within and beyond the verbal domain. The third element of our approach is a focus on the fundamental role of (the properties of) speech in language processing and acquisition. For example, we study how discrimination of speech sounds in early childhood contributes to the acquisition of phonological categories and how it affects vocabulary development. We also bring theoretical and computational work on articulation to bear on developmental speech impairments.

The overarching goal of our work is to elucidate how language processing and acquisition relate to, and can be explained in terms of, general properties of the human neurocognitive endowment. We believe that pursuing this approach will help answering the question whether language is in any sense 'special' among the human cognitive capacities, and what this 'specialness' consists of.

Our ambition with regard to societal impact is to contribute to a better understanding of language disorders, and to help improve diagnostics and treatment for people with speech/language difficulties. This ambition not only entails that we seek to translate fundamental insights on language processing and acquisition to models of language pathology, but also that we directly address questions that arise in clinical practice. We consider practice-based work important in and of itself, and we believe it will also help identify new avenues for fundamental research. Thus, a key characteristic of our group is that we explicitly work towards tightening the connections between theory-driven and practice-driven work.

As a group that is strongly empirical in its orientation and sees experimentation as the preferred method of investigation, we aspire to help promote sustainable and transparent practices in research on language processing and acquisition. This implies that we make an effort to work with robust samples of participants, and strive to be fully transparent about our methods and data. We support the use (and development) of state-of-the-art statistical methods. In concert with

initiatives around the world, we address the 'replication crisis' in the behavioral sciences by taking part in properly powered, multi-center studies⁸.

We deploy a variety of strategies in order to realize our ambitions. We devote considerable time and energy to acquiring funding for research projects that implement our ambitions. We try to make scientific impact by publishing our results in high-ranking international peer-reviewed journals, and by presenting at major conferences. We engage in collaborations with researchers in neighboring fields, such as (developmental) psychology, neuroscience, rehabilitation medicine and pediatrics. Our targeted professional audiences – speech-language therapists, (remedial) teachers, and other professionals in health care and education -- are addressed via publications in professional journals, lectures, workshops, and post-graduate teaching. We also collaborate with professional organisations and organisations that provide care and education for individuals with language and speech difficulties.

2. Relevant indicators

Authorized indicators of the group's research quality are its publications, as indicated by the quality of publication venues. This holds for both journal papers and chapters in scholarly books. We consider contributions to conferences and (ensuing) publications in proceedings volumes as indicative as well, since most of the major conferences in the field are competitive, operationalized by low (20-30%) acceptance rates. The use of our research products can be evaluated on the basis of citation metrics. Recognition of our work by the research community is primarily reflected in obtained research grants. Reasoned indicators of academic recognition include membership of editorial boards and scientific councils, and keynote/invited lectures at international conferences. Indicators of societal relevance include publications targeting professionals (specifically in health care and [special] education), policy advising for professional and stakeholder (e.g. patient) organizations, instructing and mentoring professionals, developing instruments (e.g. diagnostics) for use in professional settings, and research projects in collaboration with professionals or other stakeholders (e.g. patient organizations). Marks of recognition from societal groups are memberships of civil society boards or advisory bodies, and funding for applied and practice-oriented research.

3. Scientific and societal results in the past period

3.1 Domain general mechanisms in language

Our ambition to elucidate the role of domain-general neurocognitive mechanisms in language processing and language acquisition is reflected in a range of projects. For example, Grama (PhD 2017⁹), supported by an NWO *Graduate Program* grant, studied language learners' detection of non-adjacent dependencies (in miniature artificial languages), focusing on cognitive and

⁸ <https://osf.io/rpw6d/>

⁹ <https://www.lotpublications.nl/learning-non-adjacent-dependencies-a-mechanism-for-language-acquisition>

perceptual factors that modulate this process. Capel's work (NWO *TopTalent* grant; PhD expected December 2018), addresses the question if statistical learning involved in language acquisition and statistical learning in other domains are subserved by a single cognitive mechanism.

Avrutin has initiated a line of work in which information-theoretic notions and tools are employed to explain phenomena in language acquisition and (disordered) processing. This has resulted in innovative dissertations by Manika (PhD 2014) on sentence processing¹⁰, and Van Ewijk (PhD 2013) on lexical retrieval in language disorders¹¹. In a recently started PhD project (funded by an NWO *PhDs in the Humanities* grant), Radulescu connects information theoretical notions with implicit (statistical) learning of (artificial) language, exploring the hypothesis that rule and category formation in language acquisition is propelled by a discrepancy between input complexity and processing ('channel') capacity. This work is raising significant interest; Radulescu gave oral presentations at the most prestigious conferences in the field (AMLaP, CUNY). Judit Gervain (Paris Descartes), a leading researcher in the field of infant studies, invited Radulescu to her lab for collaborative work involving NIRS in infants. The theoretical underpinnings of this work are further developed in collaboration with the physicist Dr. Ramon Guevara Erra (Paris Descartes).

3.2 Typical vs atypical language processes

Another key feature of our work is the juxtaposition of typical and impaired language. Capel's PhD project sought to determine if adults with dyslexia (and infants with high familial risk) differ from non-dyslexic adults (and low-risk infants) with regard to statistical learning ability. Similarly, Goldberg (PhD, 2014¹²; supported by a *Neuroscience and Cognition Utrecht* grant awarded to Wijnen and Kappelle [UMCU]), compared dyslexic and non-dyslexic adults' capacity for implicit learning of artificial grammars. The hypothesis that deficient statistical learning is a key factor in developmental language disorders (DLD, dyslexia) is also addressed in Judith Rispens's (UvA) NWO-VIDI project¹³, in which Wijnen is co-PI.

Van Egmond's recently completed PhD project (funded by an NWO *Graduate Program* grant) investigates if Zipf's law can model word frequency distributions in small samples, spoken language, and aphasics' speech. The results suggest that Zipfian analysis can assist in identifying the source of language-impaired people's word-finding difficulties¹⁴. The analysis techniques developed by Van Egmond can also be used for classification of patients and tracing their recovery.

¹⁰ <https://www.lotpublications.nl/understanding-bit-by-bit-understanding-bit-by-bit-information-theory-and-the-role-of-inflections-in-sentence-processing>

¹¹ <https://www.lotpublications.nl/word-retrieval-in-acquired-and-developmental-language-disorders-word-retrieval-in-acquired-and-developmental-language-disorders-a-bit-more-on-processing>

¹² <https://www.lotpublications.nl/imprints-of-dyslexia-imprints-of-dyslexia-implicit-learning-and-the-cerebellum>

¹³ <http://progracy.com/>

¹⁴ van Egmond, van Ewijk & Avrutin (2015); Kyriaki, van Egmond & Avrutin (2017).

3.3 Speech as a fundament

Our work in psycholinguistics and language acquisition interfaces with speech science, conceptually as well as instrumentally. Quené and Nootboom jointly authored a series of studies on monitoring and error correction in speech production.¹⁵ Quené is also one of the initiators of the D-LUCEA project¹⁶, designed to study phonetic convergence in English as a lingua franca in a community of native speakers of many different languages.

De Klerk's ongoing PhD research, which uses data from the NWO open competition program *Category formation in phonology and grammar: distributional learning in children with and without a developmental language delay* (2007-2011; PI Wijnen), focuses on the development of (native and non-native) speech sound discrimination and its association with later lexical acquisition¹⁷. Ao Chen's NWO VENI project (awarded 2016) extends this line of work by looking at the interaction between distributional phonetic learning and word learning.

3.4 Toward better diagnostics and treatment of language disorders

Research that compares typical and disordered language and speech processing and acquisition may contribute to a better understanding of language pathology, but does by itself not lead to improving clinical practice. Our group also invests in dedicated, applied and clinical research. The work of Gerrits and her group at HU focusses on efficacy and innovation of intervention for adults and children with language disorders. This research connects methods used in clinical linguistics and psycholinguistics with health science and clinical epidemiology. Zwitserlood is leading the project 'ZINnig' aimed at developing a metalinguistic and multimodal intervention program for children with DLD, both based on state of the art knowledge of typical and atypical grammatical development (funded by *NWO RAAK MKB*). Van Ewijk is supervising projects on (online) intervention for adults with aphasia after stroke. She is leading the multicenter study *CommuniCare* concerning communication in care for persons with aphasia (funded by *NWO RAAK Publiek*). Bruinsma's PhD project (funded by *NWO Doctoral Grant for Teachers & HU*; supervised by Gerrits and Wijnen) has two components: 1) a large-scale cohort study that exploring the contributions of child-internal and external factors impact the developmental trajectory and attainment level of children with DLD; 2) an effect study comparing standardized 'communicative language therapy' with usual care. Van Doornik's PhD project (funded by *HU*; supervised by Terband, Gerrits, and McLeod [Charles Sturt University, Australia]) seeks to objectively define severity of childhood articulatory disorder and to relate this to communicative handicap. Singer's project (funded by *HU*; supervised by Gerrits, Gorter [McMaster University, Canada & UMCU] and Luinge [Hanzehogeschool Groningen]) is developing and validating instruments to assess impact

¹⁵ Nootboom & Quené, 2013a, 2013b, 2014, 2015.

¹⁶ Orr, R. & Quené, H. (2017). *D-LUCEA: Curation of the UCU Accent Project Data*. In J. Odiijk & A. van Hessen (Eds.), *CLARIN in the Low Countries* (pp. 181-193). London: Ubiquity Press.

¹⁷ de Klerk, de Bree, Kerkhoff, & Wijnen (2018); de Klerk, Veen, Wijnen, & de Bree (under review)

of child language disorders on daily functioning. Gerrits is co-initiator and co-PI of EU COST Action IS1406 *Enhancing children's oral language skills across Europe and beyond*¹⁸, a collaboration focusing on interventions for children with difficulties learning their first language.

We are building bridges between applied research and theory-driven work. An example is Zwitserlood's PhD project (completed 2014; funded by *Koninklijke Auris Groep*), which charted developmental language profiles of school-age children with DLD and tested an approach to intervention engaging these children's metalinguistic abilities¹⁹. A recently started study, *Language impairment in the 22q11.2 deletion syndrome: a model for SLI?* (NWO Open Competition; PIs Wijnen, Gerrits, Duijff [UMCU] and Vorstman [Toronto]), seeks to relate language impairment in children with a genetic disorder to deficiencies in neurocognitive mechanisms assumed to be critical for language acquisition, and at the same time aspires to contribute to diagnostics and prognostics. Further examples are Ao Chen's work (with Wijnen and Schnack; funded by *UU Dynamics of Youth*) on predicting (high risk of) dyslexia from early vocabulary development (Chen et al., 2017), and Terband's *NWO VENI* project, in which he used experimentation and computational modeling in studying the development of speech and articulation disorders in children²⁰.

3.5 Recognition and scientific output

As the overview above indicates, the group has succeeded in acquiring a range of grants. In fact, nearly all of the research mentioned thus far was supported by local, national or international grants or stipends.

Our work has been widely disseminated among our academic peers. From 2012 to 2017, group members have published 85 scientific peer-reviewed journal papers and chapters in books or proceedings volumes, as well as 4 books/ edited volumes. Six dissertations were completed, and numerous papers and poster were presented at international conferences, many of which were peer reviewed. (See UIL OTS report for complete figures.)

Senior members of the group have been invited to present (keynotes) at international conferences, such the *Experimental Psycholinguistics Conference*, and the *International Conference on Languages and Linguistics*, and gave invited talks at universities and research institutes abroad (e.g. University of Maryland, Chinese Academy of Social Sciences, Beijing Language and Culture University, Nanjing University, University of Verona, University of Ulster). Avrutin is member of the editorial board of the journals *Language Acquisition*, and *Journal of Neurolinguistics*, and has edited a special issue of *Brain and Language*²¹. Wijnen was on the

¹⁸ http://www.cost.eu/COST_Actions/isch/IS1406

¹⁹ Zwitserlood, Wijnen, van Weerdenburg, & Verhoeven (2015).

²⁰ see e.g. Terband, Maassen, Guenther, & Brumberg (2014).

²¹ Avrutin was also recently appointed review editor of *Frontiers in Artificial Intelligence - Language and Computation*.

editorial board of the journals *Linguistics* (until 2014); *Journal of Fluency Disorders* (until 2017), and currently serves as editorial board member of *First Language*, and *Stem- Spraak- en Taalpathologie*.

The overview so far indicates that we frequently engage in cross-disciplinary collaborations. Further examples are Terband and Keij's (now *Koninklijke Auris Groep*) work with colleagues in the Faculty of Social and Behavioral Sciences, on a study investigating the association between communication difficulties and behavioral problems in children (seed money grant from *Dynamics of Youth*).²² Wijnen, Gerrits, Blom (Social & Behavioral Sciences), Bolhuis (S&BS), Wierenga (Sciences) and Pasterkamp (University Medical Center) were awarded a significant grant from *Dynamics of Youth* for an interdisciplinary research program on early brain and language development (*1001 Critical Days: The Language of Brain Development*²³), which aims at building bridges between fundamental science and questions concerning parenting practices and counteracting risk factors for developmental problems.

3.6 Societal impact

Since much of the work in the group connects to clinical practice, group members make an effort to contribute to books directed to professionals, e.g. *Dyslexie 2.0 - Update van het Protocol Dyslexie Diagnostiek en Behandeling* (Wijnen); *Klinische Neuropsychologie / Clinical Neuropsychology* (Wijnen, van Ewijk); *Handboek Taalontwikkelingsstoornissen* (Gerrits, Beers, Bruinsma & Singer, 2017), and they write in professional journals, e.g. *Tijdschrift voor Logopedie*. We also engage with professionals in conferences and seminars. Gerrits, Terband, and Wijnen served on the organizing committees of *TaalStaal* conferences (2012, 2015, 2017)²⁴, reaching some 400-600 professionals working with children with language disorders at a time. Gerrits and co-workers contributed to conferences of the *Nederlandse Vereniging voor Logopedie en Foniatrie* (Netherlands Association of Speech-Language Therapists; NVLF) and the *SIMEA* foundation, targeting SLTs and teachers in schools for children with speech/language difficulties. Wijnen co-organized and presented at conferences of the *Stichting Dyslexie Nederland* (Netherlands Dyslexia Foundation; SDN). Gerrits regularly teaches post-graduate courses for SLTs and other health care professionals.

Senior members of the group have been involved (as board members or advisers) with organisations catering for professionals in speech and language pathology. Gerrits is board member of the *International Association for Logopedics and Phoniatics* (IALP), chair of the Dutch association for voice, speech and language pathology (NVSSTP). She initiated the NVLF's scientific advisory board, and directed the establishment of the *Kennisagenda Logopedie* ('knowledge agenda speech-language therapy', funded by *NWO ZON-MW*). We collaborate with the *Koninklijke Auris Groep*, a major institution providing care and education to individuals with speech, language

²² <https://www.uu.nl/en/news/interdisciplinary-research-on-the-interplay-between-communication-and-behaviour-thanks-to-seed-money>

²³ www.uu.nl/1001days

²⁴ <http://www.taalstaal.nl/>

and hearing difficulties. Wijnen was board member of the *Stichting Dyslexie Nederland* (until March 2017), and chaired a consultative committee in the *Goud in Handen* project initiated by the Dutch association for people with dyslexia 'Woortblind', 2010-2013. Gerrits (with Visser-Bochane and others) developed the evidence-based clinical guideline Speech and Language Therapy for children with developmental language disorders (2017).²⁵

Instruments for the clinic and special education

In close collaboration with *Boom Publishers*, Zuckerman and Pinto (research group LTLA) are developing a new Dutch vocabulary test for preschool children, based on their 'coloring book' paradigm. Terband and Van Doornik translated the *Intelligibility in Context Scale*, and normed it for the Dutch population. Terband also made significant contributions to the *Computer Articulation Instrument (CAI)*, which provides innovative process diagnostics of developmental speech disorders. Wijnen contributed to the formulation of guidelines for diagnosis and treatment of developmental dyslexia (published by SDN²⁶). Zwitserlood developed the *MetaTaal* metalinguistic intervention approach for school-age children with SLI. Gerrits and her co-workers (at HU) developed the *FOCUS-NL observatielijst communicatieve participatie kinderen tot 6 jaar*, *ICS-NL* (intelligibility in context scale for parents of children with speech production disorders), also as a web based version (funded by *Damsté Terpstra Fonds*), *ENGAGE* ('ENGaging parents in Goal Articulation and Goal Evaluation', a tool for parents of children with language disorders; funded by *FondsNutsOhra*), *SAQoL-39NL* (quality of life questionnaire for people with aphasia), *Dutch Naming Test* (assessment of word finding in adults), and *DigiTAAL* (database of tablet-based games in speech and language therapy; funded by *NWO RAAK publiek*).

Public outreach

To inform the general public, specifically also children, about work in the group, members have given presentations at a variety of venues, such as *MuseumJeugdUniversiteit* (Utrecht, 2016), *KinderCollege* (Bergen op Zoom, 2016), *Meet the Professor* (2016, 2017), *Scientist in the classroom*, *Rector's League*, *Weekend van de Wetenschap* (Science Weekend), and the annual *Drongo Language Festival*.

4. Conclusions of the self-evaluation

It is clear from the overview in section 3 that the group has made many contributions to the field, the large majority of which can be considered to be of high quality, as indicated by our publication venues. The recognition of our work is also indicated by our success in acquiring research funding, at local, national, and international levels, as well as by group members' invited contributions to international events and research collaborations. A strong point of our group is that fundamental work on language processing and acquisition, with a specific focus on their neurocognitive underpinnings, is connected to applied and clinically oriented research, which evidently caters to

²⁵ <https://www.nvlf.nl/actueel/2017/openbaar/download-nu-de-richtlijn-logopedie-bij-tos>

²⁶ <http://www.stichtingdyslexienederland.nl/publicaties/brochures-sdn>

the needs of professionals in care and education for individuals with speech and language difficulties. In principle, the viability of the (type of) work done by the group members is high, particularly in light of the high societal costs associated with language disorders in both children and (elderly) adults. In practice, given the group's small size and its lopsided composition, particularly due to the absence of mid-career personnel, its sustainability is a cause for some concern.